

CONTROL SENSOR HOUSING WITH PROTECTIVE LAMINATE

BACKGROUND OF THE INVENTION

5 This invention relates generally to protective housings for control sensors used in harsh operating conditions. More particularly, the present invention relates to a control sensor housing having an exterior surface that is provided with a laminate that is resistant to weld flash, high temperatures, pitting, abrasion, acidic and caustic solutions, solvents, and the like.

10 Robotics and automation have been used in manufacturing for many years. A typical use for robotics and automation is in the automotive industry, and particularly in operations such as car body assembly. In such an operations, welding instead of bolting or riveting is the preferred method of joining car body parts together. This produces consistent, predictable results and the assembled car bodies are not only stronger and better able to resist vibrations, they are less likely to develop squeaks and rattles as they age. Car body fabrication generally involves moving a chassis or platform along an assembly line past a series of welding stations that join car body components such as door pillars, firewalls and floor pans together at predetermined weld locations on the chassis. Since the car body components are not all the same size and shape, it will be appreciated that different types of welds may be required. For instance, a door pillar may require one type of weld, a firewall may require another type of weld, and a floor pan may require yet another type of weld. And, since welding units are somewhat specialized, each welding station is often equipped with a plurality of different welding set-ups, so that a welding station may be equipped with stationary or mobile spot welding units that are used to join pieces of sheet metal together. Or, the welding station may include stationary or mobile units equipped for welding thick frame members together with a single bead.

25 It will be appreciated that it is not uncommon to fabricate different models or makes of vehicles at a single plant. That is, a particular car may be available as a coupe, a sedan, or a convertible. Or, a plant may be used to fabricate different makes of cars within a family of cars. In situations like this, welding requirements will vary

between vehicle models and makes, and welding stations may be provided with extra welding units.

In such aforementioned welding units, welding operations are often partially controlled by sensors that detect the presence or absence of a work piece at a particular, predetermined location, or which monitor and control robotic units as they traverse along predetermined paths of motion. Such sensors are available in a wide variety of shapes and sizes and are usually referred to generically as proximity detectors. Because of the harsh work environment inherent to welding stations, such sensors are usually provided with protective housings. Usually, at least one wall of the protective housing is composed of a non-metallic material such as glass reinforced thermoplastics or thermoset plastics against which the working end of the sensor is positioned and through which the sensor may operate. Such housings are also typically provided with brackets and fittings that allow the housing and sensor to be operatively connected to supports and other electrical components, respectively. In use, these protected sensors are usually positioned near the welding electrodes or rods so that they are better able to determine when a work piece and/or welding electrode or rod is in the correct position for welding. As one might expect, the closer a sensor is positioned to a welding electrode or rod, the more apt it is to be exposed to weld flash and high temperatures.

Additionally, sensors may be subject to accidental impacts from a variety of sources, inadvertent contact with corrosive chemicals, or temperature extremes, all of which may shorten the operational life of the sensors. For example, a sensor may be impacted and scratched by machinery that has become broken, bent or misaligned. Or a sensor might become inoperable due to contact with highly reactive materials used during fabrication, or corrosive chemicals used during periodic cleaning. Or the sensor might be exposed to ambient temperatures in excess of its designed operational range.

Of the aforementioned operational conditions, weld flash is of the greatest concern because it cannot be easily ameliorated or eliminated. Weld flash occurs during the welding operation and comprises small bullet-like projectiles of molten weld material that are randomly ejected from the weld site by minute impurities in the weld material as they are consumed by the heat generated by the welding electrodes or rods.

working conditions will ultimately require replacement - in as little as 500 weld cycles per welding unit. And each time a sensor has to be replaced, the assembly line must be shut down for servicing. One can appreciate the magnitude of the problem this creates when one considers that there may be a plurality of assembly lines, and each assembly line may have a plurality of welding stations, and each of these welding stations may have a plurality of sensors, and each sensor is subject to the effects of weld flash damage and high temperature. And as one may imagine, replacing such sensors can result in significant down time.

Initially, thermoplastic materials such as glass filled nylon 6 and glass filled nylon 6.6 were used for the non-metallic sensing surfaces of sensor housings. With this type of material, small bits of slow moving weld flash having low levels of kinetic energy were able to bounce off, due to the material's somewhat resilient nature. However, because of the thermoplastic's relatively low glass transition and melting points, they were susceptible to impacts by the larger bits of hot weld flash having higher levels of kinetic energy, which formed pits primarily by melting the material. In an effort to reduce pitting, thermoset materials were tried. Because thermoset plastic materials have relatively higher glass transition and melting points, they were better able to resist pitting caused by hot weld material and higher temperatures. However, they were comparatively more brittle than the thermoplastics and were susceptible to pitting due to impacts of weld flash that knocked off fragments of the material. Thus, accretions of weld flash were able to form on both types of materials.

In an effort to minimize and/or reduce the effect of weld flash on non-metallic sensing surfaces, other materials such as Kevlar ® and ceramics have been tried. However, these materials suffer from the same drawbacks as the above-mentioned thermoplastics and thermoset plastics. That is, they are either too soft or too hard and do not solve the problems associated with weld flash, namely the accretion of weld material on the sensing surface of the housing.

There is a need for a housing for a control sensor that is able to withstand weld flash, abrasion, impacts, and high temperatures. There is also a need for a housing for a control sensor that may be fabricated inexpensively and quickly using known techniques and technologies.

BRIEF SUMMARY OF THE INVENTION

1 The present invention comprises a housing for a control sensor. The housing
5 has an attachment end, a body and a sensing end. The sensing end includes a cap
that, with the body and the attachment end, forms an enclosure. A control sensor,
detector, or similar device is positioned within the enclosure and arranged so that it is
able to operate through an end wall of the cap in a normal fashion. Preferably, the end
10 wall of the cap comprises thermoplastic or thermoset plastic, although any material that
allows electromagnetic waves to pass therethrough in sufficient strength to be able to
be detected by a sensor may be used. Preferably, the end wall of the end cap
comprises glass filled nylon 6.6, nylon 6, thermoset plastic X655 (manufactured by
Vyncolit N.V., Ghent, Belgium), polyvinylidene fluoride (PVDF), or like material. The
15 end wall of the cap has an outer surface that is provided with a laminate of material that
also allows transmission of electromagnetic waves therethrough. The laminate provides
the end wall of the cap with protection against harsh environments, and in particular
against the effects associated with weld flash. Of the various types of laminates that
have been tried, it has been discovered that laminates that contain material having low
20 coefficients of friction work better than other laminates with relatively higher coefficients
of friction. And of those materials, the best results have been obtained with materials
such as molybdenum disulfide, graphite, and polytetrafluoroethylene, either singly or in
combination with each other, and preferably dispersed in a mixture of resinous matrix.
These mixtures are usually combined with an evaporative carrier that allows the mixture
to be applied in liquid form and are commonly available as dry-film lubricants.

25 It has been found that dry-film lubricants instead of conventional laminated
materials are particularly suited for this type of application not only because they are
able to resist the high temperatures of weld flash, but also because they are able to
resist the pressures generated by weld flash impacts. And, because dry-film lubricants
are applied in relatively thin layers, they are able to utilize the inherent resiliency of the
30 underlying support material and cushion the impacts of the weld flash. Moreover, the
plate-like structure of some of the lubricants, notably graphite, appears to facilitate "self

healing.” A dry-film lubricant that is particularly suitable for use as a protective laminate for sensor control housings is Everlube ® 10026, manufactured and sold by E/M Engineered Coating Solutions, 100 Cooper Circle, P.O. Box 3969, Peachtree City, Georgia 30269. It is understood, however, that other dry-film lubricants having the same properties may be used.

An object of the present invention is to provide a control sensor housing that is able to resist harsh work environments.

It is another object of the present invention to increase the operational life of a control sensor.

A feature of the present invention is that a control sensor housing may be toughened using known technologies and techniques.

Another feature of the present invention is that toughness may be imparted to a non-conductive surface of a control sensor housing by utilizing a protective material.

An advantage of the present the invention is that the protective material may take the form of a laminate that can be operatively attached to a wide variety of materials.

Additional objects, advantages and features of the invention will be set forth in part in the description which follows, and in part will become apparent to those skilled in the art upon examination of the following or may be learned by practice of the invention.

The objects and advantages of the invention may be realized and attained by means of the instrumentalities and combination particularly pointed out in the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a preferred embodiment of a housing of the present invention;

FIG. 2 is an exploded, perspective view of Figure 1 illustrating the components of the housing and the position of a sensor contained therein;

FIG. 3 is a partial, exploded, perspective view of the sensing area and laminate

of the housing of Figure 1;

FIG. 4 is a partial, cross-sectional view of a preferred embodiment showing a housing with a sensor positioned therein, and a welding unit in spaced relation from each other; and,

FIG. 5 is a perspective view of a preferred embodiment of a housing of the present invention showing an accretion of weld flash on a sensing surface of the housing.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to Figure 1, a preferred embodiment of a control sensor housing is depicted. This housing 10 includes an attachment end 12 a body 18 and a sensing end 20. The attachment end 12 includes an attachment bracket 14 and an electrical fitting 16 that are used to operatively connect the housing to a support and electrical components, respectively. The body 18 of this preferred embodiment includes four walls 22, 24, 26, and 28 (see also, Fig. 2) that form an enclosure into which a control sensor "S" is positioned. The sensing end 20 of the housing, as depicted, includes a sensing surface 52 which will be discussed below in greater detail.

It should be understood that while the preferred embodiment of the housing is depicted as being substantially cubical, other configurations are possible, for example, barrel shaped, cylindrical or rectangular. Moreover, it should also be understood that the location of the sensing end could be oriented in a different direction, relative to the attachment bracket. Thus, the sensing end could be located at side 22, for example.

Referring now to Figure 2, the housing 10 has been partially disassembled so that the components may be more easily identified and described. As depicted, the sensing end 20 of the housing 10 includes a cap 30 having an end wall 32 with an outer surface 46 onto which a laminate 50 has been operatively attached. The cap 30 includes sides 34, 36, 38 and 40 (see also, Fig. 3) which are arranged and configured to so that they are adjacent sides 24, 26, 28 and 22, respectively, and lie in the interior of

body 18 in a nesting relation.

Referring to Figure 3, the sides 34, 36, 38 and 40 along with the inner surface 42 of the cap 30 define a cavity 44 into which a portion of the sensor "S" may extend. As can be seen, the laminate 50 has a slightly larger surface area than the end cap 32.

5 This allows the laminate to also cover the ends of walls 22, 24, 26, and 28 so that a continuous, unbroken layer covers the entire sensing area 20 of the housing 10 (see, Figure 4). As mentioned above, the laminate 50 includes material that has a low coefficient of friction, such as molybdenum disulfide, graphite, or polytetrafluoroethylene that is dispersed either singly or in combination with each other in a resinous substrate.

10 And, such materials are most often found in dry-film lubricants such as Everlube ® 10026. It will be appreciated that dry-film lubricants are most often applied in spray form and usually in thicknesses of around 1-10 mils. Thus, it should be apparent that the laminate 50 as depicted figures 2, 3 and 4 is not to scale. Rather the laminate, as depicted, is exaggerated to facilitate a clearer understanding of the invention.

15 In this preferred embodiment, the laminate 50 is applied to the outer surface 46 of the end wall 32 of cap 30 in spray form and allowed to cure thereon at ambient temperature for about seventy-two hours. In order to promote a better interface between the outer surface 46 of the end wall 32 and the inner surface 54 of the laminate, it may be necessary to roughen or otherwise texture the outer surface 46 of the end wall 32. This may be done by mechanically working the outer surface 46, preferably by bead blasting. After the outer surface 46 of the end wall 32 of the cap 30 has been worked, it may be further prepared to remove any extraneous matter that may interfere with proper adhesion. The laminate material is then applied, preferably in spray form. As mentioned above, the thickness of the laminate is about 1-10 mils.

20 However, the more desired thickness is in the range of 2-7 mils and more preferably 2-4 mils. It will be appreciated that precise thickness of a laminate may be achieved by applying the material in several thin layers rather than one thick layer. And, while the preferred method of applying the laminate is by spraying, it is understood that the laminate material may be applied by other conventional methods, such as dipping or brushing or tumbling. Alternatively, it is envisioned that the laminate be formed as a sheet of material that may be adhesively or otherwise attached to the outer surface 46

of the end wall 32. It is also envisioned that the cap 30 and attached laminate 50 be removably and interchangeably attached to the body 18 of the housing 10.

Referring now to Figure 4, a partial, sectional view of the housing is shown as it may be used in conjunction with a welding unit. In this preferred embodiment, the sensor "S" is an inductive proximity detector and it is oriented so that its sensing end is adjacent inner surface 42 of the end wall 32 of the cap 30. From this position, the sensor "S" is able to detect when the work pieces 70, 72 are in the correct position for welding. Although the preferred embodiment of the control sensor "S" is an inductive proximity detector, it should be apparent that other detectors and sensors that utilize electromagnetic waves may be used, for example, infrared, magnetic, VHF, UHF, radio, etc.

Note, in this figure, that the housing 10 is positioned so that the sensing surface 52 is in the center of the weld zone where most of the weld flash 80 is likely to be produced. It is understood, however, that the housing 10 and sensing surface 52 need not directly face the welding unit. For instance, the sensing surface 52 may be angled or parallel with respect to the work pieces 70, 72 (not shown). Or, the housing 10 and sensing surface 52 may be positioned to the right of the welding electrodes 60, 62 (not shown). It is also understood that there may be more than one sensor at a particular welding unit to enable, for example, the location of a plurality of work pieces to be monitored (not shown).

Because only the sensing area 20 need be transparent to electromagnetic waves, it is often desirable to fabricate the remainder of the housing from other, more durable material. Thus, it will be appreciated that the side walls 22, 26 of the body 18 are depicted in cross-section as being metallic material. Some of the more desirable materials for housing bodies include anodized aluminum and stainless steel, but other similar material could be used.

The partial welding unit depicted in the figure is a spot welding unit of the type having opposing electrodes 60, 62 that simultaneously clamp work pieces 70, 72 together and pass a high electrical current therebetween. As mentioned above, during the welding process, bits of hot weld material, known as weld flash 80, are ejected from the weld site. As depicted, the weld zone for the partial spot welding unit is primarily to

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the left of the weld site. It will be appreciated, however, that different welding set-ups will have different weld flash zones. For example, a welding rod that is used to join thick pieces of metal together will have a differently shaped weld zone (not shown).

Referring now to Figure 5, a housing 10 that does not have the
5 aforementioned protective laminate is depicted. As can be seen, an accumulation or accretion 90 of weld flash 80 is depicted in the center of the sensing surface 52. It should be understood, however, that accretions such as the one depicted may form over the entire sensing surface in a more or less even pattern, or in concentrations that are off-center.

10 The present invention having thus been described, other modifications, alterations or substitutions may present themselves to those skilled in the art, all of which are within the spirit and scope of the present invention. For example, it is envisioned that the sensor cap 30 or the entire sensor housing 10 and cap 30 assembly could be formed from a material which is resistant to weld flash and has the requisite
15 toughness. It is therefore intended that the present invention be limited in scope only by the claims attached below: